Bridging Spatial and Tabular Data Using MapWinGIS ActiveX Control In A Natural Resource Monitoring Database

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Developing a caribou monitoring database: A case study

Natural resource monitoring databases often consist of a mixture of tabular and spatial data. The presence of spatial data frequently complicates application development due to the paucity of Rapid Application Development (RAD) tools specifically designed for spatial data. Developers are forced to choose between shifting the whole data management system into a GIS to solve the problem or cobbling together a 'home grown' solution using traditional tabular data management tools. The former system requires highly trained personnel to develop and use the system and is often overkill for data models that are light on spatial data. The latter solutions have the benefit of fast development and maintenance using RAD tools and a relational database but often sport a clunky architecture with software-imposed walls separating the tabular data from the spatial data. They typically offer little in the way of programmatically enforced data integrity between the two halves.

The National Park Service Arctic Network Inventory and Monitoring Program (ARCN) encountered this tabular/spatial data management divide when modeling a data management architecture for it's caribou monitoring program. The data model was mostly tabular in nature but also had a small but critical spatial component consisting of GPS fixes of collared caribou (Figure 1).

At the outset we recognized we lacked the expertise to develop a full-blown GIS and felt that building an application using ArcGIS and ArcObjects was far beyond our abilities and perhaps overkill for the small amount of spatial data we planned to manage. We decided that we wanted the robust data quality protections afforded by a tried and true relational database (Microsoft SQL Server) coupled with an efficient front end application (Microsoft Access, Figure 2). But how would we visualize and edit the spatial data?

The MapWinGIS ActiveX GIS Control

All of our system requirements existed already except for a suitable spatial data visualization tool. How would we view and edit the GPS fixes while performing quality assurance operations? We needed a robust, easy to program control that could be embedded in our front end application. We soon discovered the MapWinGIS ActiveX GIS control. This tool consists of an ActiveX control called MapWinGIS.ocx, a programming object that can be added to a form and programmed using any language that supports ActiveX. The control can be embedded in a RAD environment such as Microsoft Access, in essence providing a built-in GIS that can be integrated with the back end data model.

How we did it

The MapWinGIS control was surprisingly easy to integrate with the caribou monitoring database. The control itself can be dragged and dropped onto an Access form. From there the background layers and data can be loaded and manipulated from a shapefile, raster or simply 'drawn' on the map as a data layer. We chose to use shapefiles for the background layers and wrote a simple Visual Basic subroutine to draw the points on the map every time the caribou locations table's record-source property is altered. Selecting points on the map, conversely alters the data table's recordsource effectively synchronizing the map and the GPS locations table. Locations can quickly be viewed, analyzed and edited in the Access front end until the data reach sufficient quality to allow analysis in ArcGIS. At that point the data can be accessed in ArcMap through a 'Database Connection' established in ArcCatalog (Figure 3 and 4).

Conclusion

The MapWinGIS can be an effective substitute for a GIS in certain data models where the spatial entities are few and simple, data management tasks are straightforward, and where there are significant advantages to be gained through a tabular data model's architecture and Rapid Application Development tools.

MapWinGIS Map Control

The MapWinGIS ActiveX control is an open-source map viewer that can be embedded in a Microsoft Access application.

MapWinGIS control is designed to use shapefiles for data storage, but for our purposes it was actually simpler and more efficient to let SQL Server manage the attribute data and simply draw the caribou locations on the map as a cartoon when needed.

In this example background layers are shapefiles. Points are 'drawn' onto a MapWinGIS DrawingLayer object every time the datatable's record-source is updated.
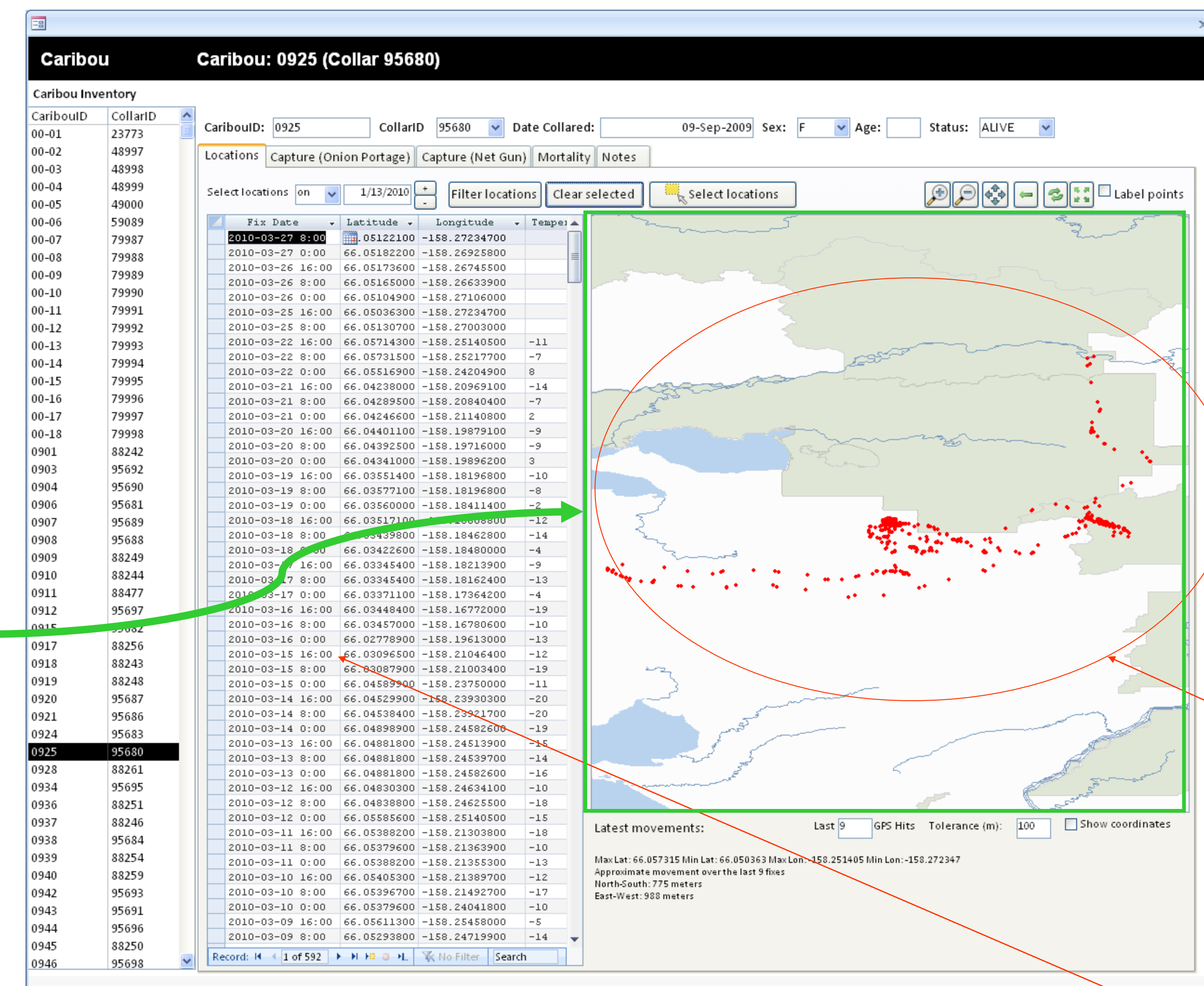

Fig 2. Microsoft Access front end application showing GPS fixes in tabular and spatial format. The map was built using the MapWinGIS ActiveX control. The background layers are shapefiles but the caribou locations are drawn from an SQL Server table. The data table and map share a recordsource updated through a Visual Basic subroutine.

Figure 3. ArcGIS Integration. The system integrates with ArcGIS through a 'Database Connection'. All SQL Server tables become available for analysis in ArcMap. Connection is one-way, however, as edits cascade from SQL Server to ArcGIS but cannot proceed from ArcGIS to the SQL Server
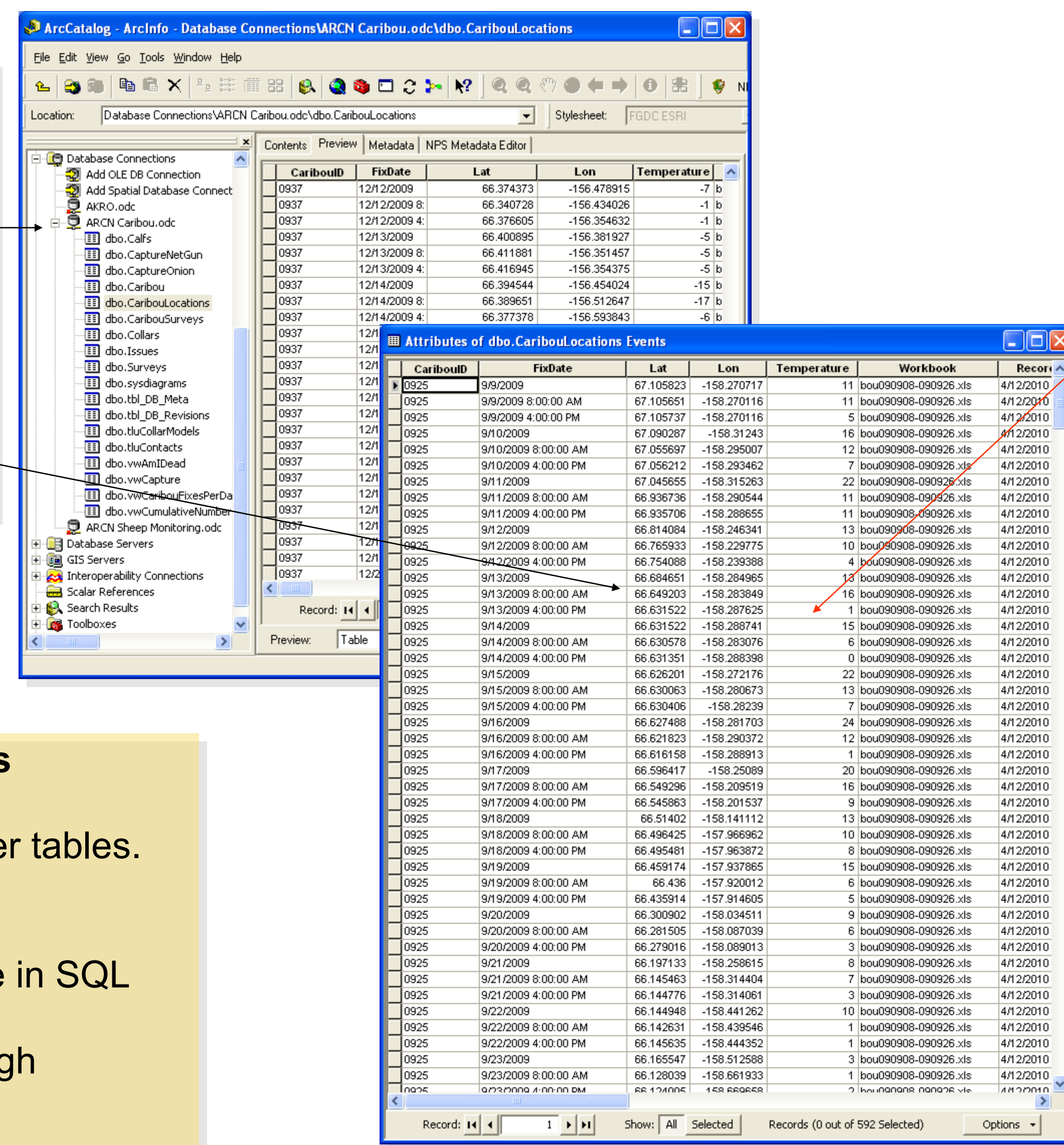
System Pros and Cons

Pros

All records are stored in SQL Server tables.
Data integrity very high.
Simple to implement
Easy to migrate to spatial data type in SQL Server 2008
Integrates easily with ArcGIS through Database Connection

Cons

One-way data flow from SQL Server to ArcGIS. All data quality control must happen in front end application before analysis by ArcGIS.

More Information

If you would like to know more about the this effort or the NPS Arctic Network and the caribou monitoring program please visit our website at http://science.nature.nps.gov/im/units/arcn/index.cfm

Information on the MapWinGIS tool can be found at http://www.mapwindow.org/

Fig 4 (Below). Caribou monitoring data shown in Figure 2 replicated in ArcMap. The SQL Server database can be accessed through the Microsoft Access front end or ArcGIS, depending on which is more advantageous. Generally QA\QC occurs in Access and data analysis in ArcGIS

TABULAR DATA   SPATIAL DATA

Why not use a GIS?

Putting the entire database into a GIS was discarded as an option for numerous reasons:

Lack of expertise in geodatabase design and ArcObjects programming

Data quality assurance concerns regarding ESRI's pseudo-relational geodatabase model.

Lack of Rapid Application Development tools in ArcGIS. It would simply take too long to develop, and would require too much skill to operate.
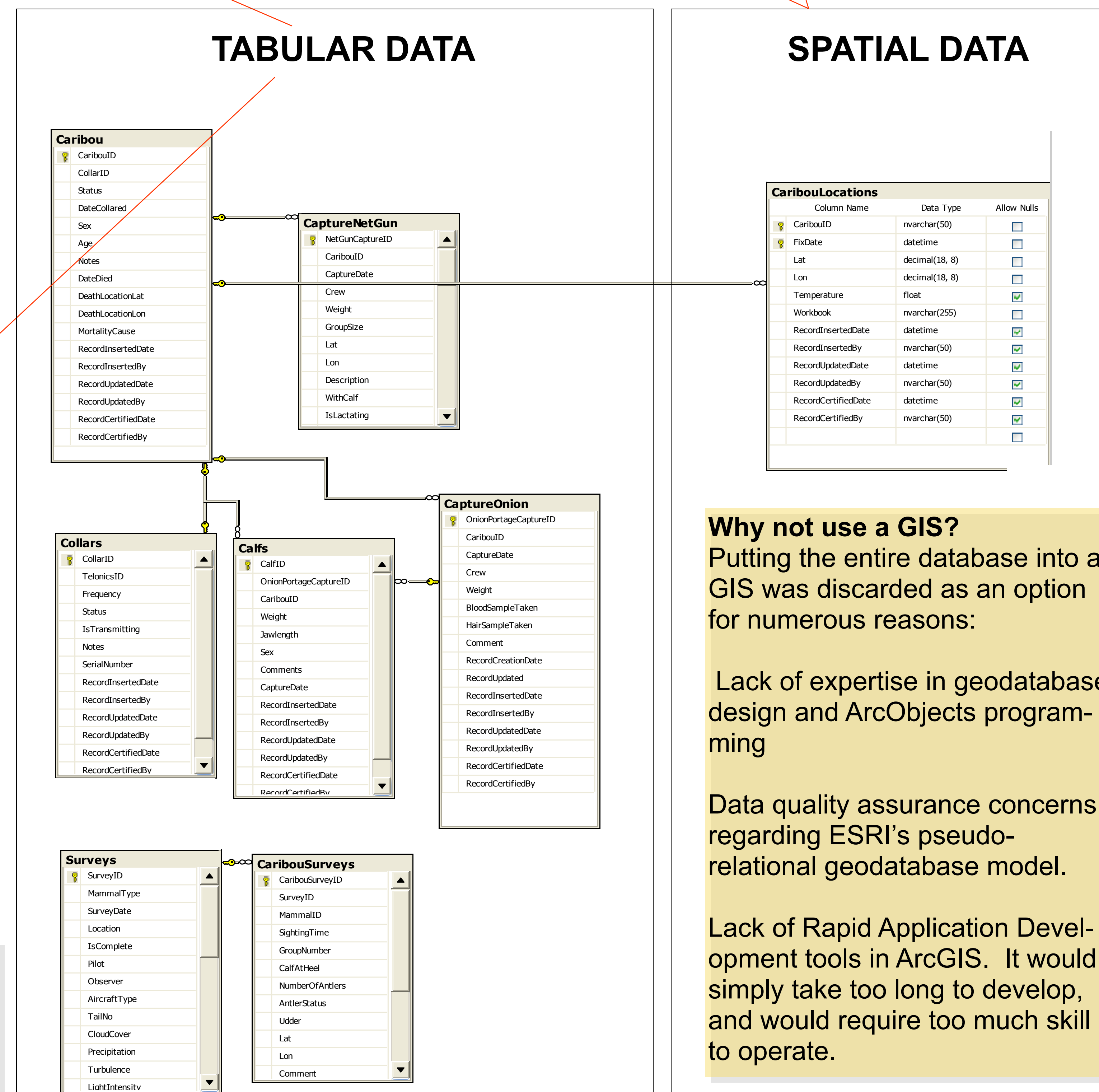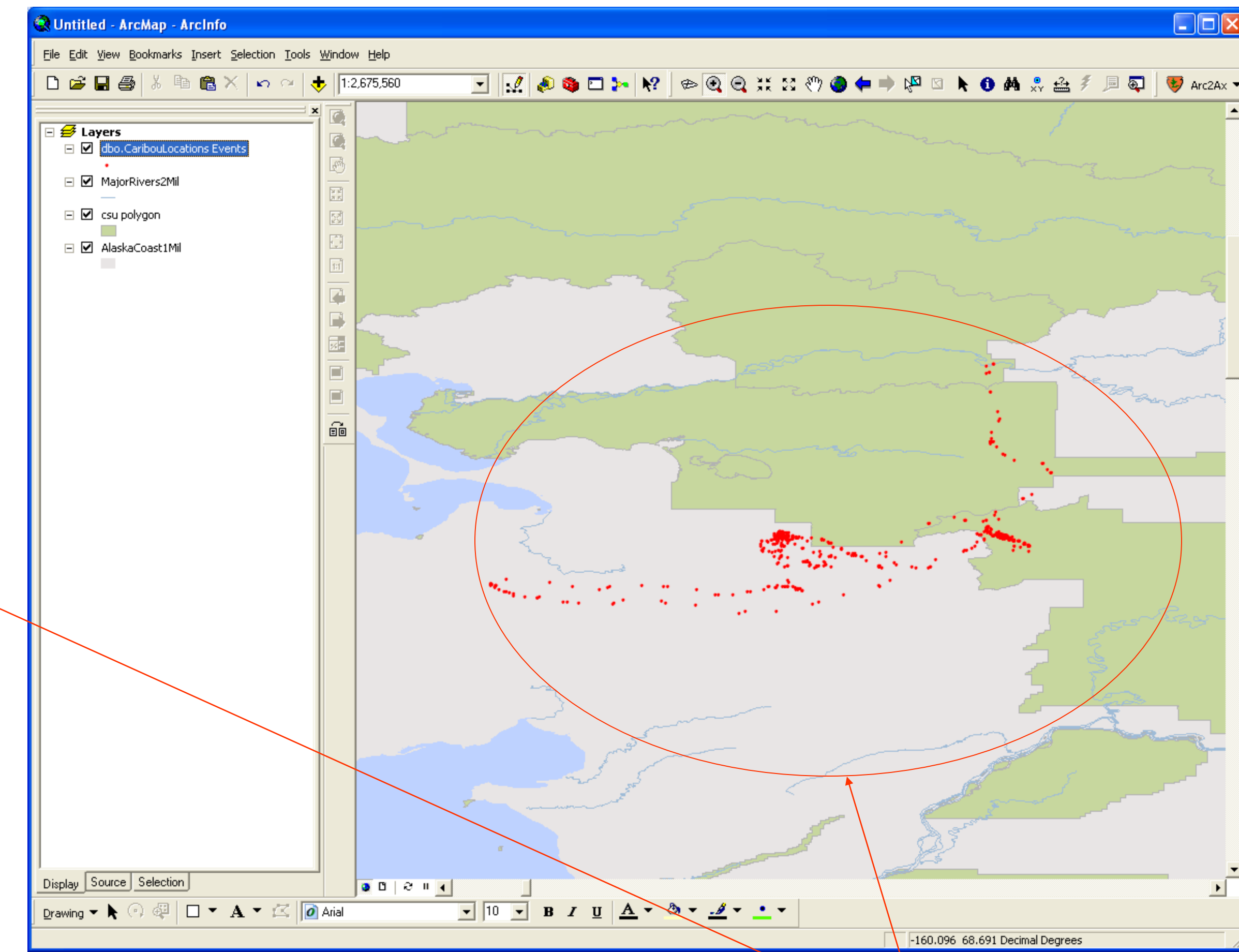
Figure 1. Simplified caribou monitoring data model (SQL Server 2005). Only one table contains spatial data, the remainder is tabular. Tabular data is shown in left swimlane, spatial data in the right.